International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 9, Issue 3, Jun 2019, 983-992

DESALINATION USING MAGNETRON

DR. T. MOTHILAL[1], ANANDHA VARMAN. B[2], ARVIND EASHWAR. R[3] & GAUTHAM. R[4]

[1]*Assistant Professor,Department of Mechanical Engineering, Velammal Institute of Technology, Chennai, India*

[2,3,4]*Student, Mechanical Engineering, Velammal Institute of Technology, Chennai, India*

ABSTRACT

This project is about suggesting a microwave excitation for and separating salts by means of distillation. To meet the requirements of individuals, water has been a basic need. This project will serve the people who face water crises. Magnetron is used as a major source for separating salt from desalinated water, where magnetron acts as a heating source providing microwaves of the frequency of 2.4 GHz, splitting water molecules to produce heat as a result, of intermolecular vibration of water molecules.

KEYWORDS: Magnetron, Saline Water, Intermolecular Vibration, Microwaves & Distillation

Received: Mar 13, 2019; **Accepted:** Apr 03, 2019; **Published:** May 22, 2019; **Paper Id.:** IJMPERDJUN2019106

Original Article

INTRODUCTION

Interest for fresh water is expanding because of industrialization, life standard and consumption of characteristic sicknesses and so on. As indicated by United Nation Organization that by 2025, right around 1800 million individuals will experience the ill effects of water shortage. In contrast to other desalination techniques, this paper centers around desalination utilizing the microwave. Microwaves are broadly utilized in correspondence purposes, remote detecting, route, sustenance preparing, and so forth. Of late, traditional research center warming is, being supplanted by microwave household warming. The focal points that pulled in the consideration of scientists to microwave warming are, 1) higher warming rates in less time, 2) no immediate contact between, the reactants and vitality source. Likewise, non-warm utilizations of microwaves incorporate estimating the dielectric properties of an extensive assortment of substances, for example, elastic, wood, paper, glass. Microwave vitality can be, changed over into warmth when dielectric material, having incited dipoles is presented to microwave radiation of certain band of recurrence. The saltiness or the salt substance in lakes seas and groundwater fluctuates extra amounts of time because of expanded surface spillovers. To assess the saltiness, a recurrence score of 0.5 to 4.0 GHz is required. NaCl is the foremost substance in salt water. Ho and Hall estimated the dielectric properties of seawater tests gathered over the world's seas, just as those of 0.3 N to 0.7 N. over a temperature scope of 5.5-240C at 2.653 GHz. The primary goal of this technique is to give a superior nature of fresh water.

LITERATURE

D H Gadani1, V A Rana, S P Bhatnagar, A N Prajapati & A D Vyas recommended that the fundamental point was to check the emissivity of saline water at fixed frequencies of 0.5, 0.9 and 1.4 GHz. The variety of complex permittivity of water with saltiness and recurrence is determined, utilizing Stogryn condition just as Klein and Swift. It is seen that, from the test, dielectric consistent of water diminishes gradually with increment in salinity. The ionic conductivity of electrolyte arrangement diminishes at high recurrence,

because of the dynamic impact of the unwinding of a particle environment. The emissivity of saline water was found to diminish with increment in saltiness level in the water.

Jamil Anwar, Umer Shafique, Waheed-uz-Zamana, Rabia Rehman, Muhammad Salman, Amara Dar, Jesus M. Anzano, Uzma Ashraf and Saira Ashraf in their paper review the study of ionic concentration and interaction of microwaves with dielectric materials. For this method, Cs+, K+, Na, Li are used. It was found that the microwaves do not deliver proper radiation. Zone heating, was also found during the process and the relative decrease in the microwave during conduction. It was observed that the water molecules collide and as a result, heat is produced. Water molecules with oxygen atoms bound to align in the field of microwaves, as a result, only free or loosely bound molecules cause water to heat.

Joseph Weibler proposed the properties of metals used for RF shielding. The factors to be considered are, the materials chosen must provide the required level of shielding. It is to minimize the quality of seams and penetrations in the enclosure to lower the potential points of deterioration, to maximize the quality of the seams and penetrations for better performance and long term reliability. The major components used were Aluminium, copper, and steel. He concluded from his experiment that those factors would help to improve the life of the material and shielding effectiveness.

Natt Makul, Phadungsak Rattanadecho, Dinesh K. Agrawal suggested that microwave warming is an exceedingly proficient strategy for different warm procedures. A portion of the upsides of microwave warming contrasted with regular preparing techniques incorporates vitality sparing, quick warming rates and short handling occasions, the profound entrance of the microwave vitality. Microwave vitality forms for warming, drying, and relieving have been created for various research center scale examinations and, sometimes, have been popularized. Microwave vitality use ought to hypothetically be invaluable in the handling of bond and solid materials (e.g., pressure driven Portland concrete, total, and water). These materials display superb dielectric properties and, consequently, ought to have the capacity to retain microwave vitality in all respects proficiently and momentarily convert it into warmth. He inferred that the dielectric permittivity of concrete based materials is influenced by bond type, w/c proportion. Abnormal state microwave vitality is utilized to penetrate the concrete. What's more, a couple of more were seen amid their procedure.

Niall J. English and J. M. D. MacElroya found that microwave heating is an important industrial process, and in recent years, there has been an increasing focus on the application of microwave radiation for a variety of physicochemical purposes. It was found that the potential energy had the opposite pattern of local maxima and minima to the kinetic energy, which may be rationalized in terms of the lowest possible UE for alignment of the molecular dipoles with the applied field and the local increase in kinetic energy due to the molecular rotations, to achieve this alignment. This resulted in the total energy of the system increasing reasonably smoothly, as the opposite local extreme in the kinetic and potential energies tended to cancel each other. This study appears to confirm the anticipation of the authors that polarizable models are more suitable for systems, in which external electric or e/m fields are present, at least for the case of water, for which charge polarization is an important physical feature.

Yu V Bykov, K I Rybakov and V E Semenov's paper review on high-temperature processing on microwave heating. They observed the fundamental notions regarding the absorption of electromagnetic waves, heat transfer and electrodynamics of single and multimode microwave cavity. A higher frequency can help in enhanced absorption in many materials of industrial interest. An important issue that was found is that high-temperature processing technology is the range of materials and applications such as the use of glass or ceramics.

MATERIAL SELECTION

Magnetron

In this, an electric field exists in the gap inside the tube. A permanent magnetic field exists perpendicular to the electric field and parallel to the length of the tube. Electrons in the cathode are stripped into the electric field due to thermionic emission (high temperature in the cathode causing the electrons to be excited and released) (Nave 2005). They accelerate towards the anode, the outside of the tube, due to the force applied to them by the electric field. However, on their way, the magnetic field also applied a force to them which curves their motion. Because of their curved motion, the electrons are pushed towards an area, where there is excess negative charge in the anode (one side of a cavity). This excess negative charge is pushed back around the cavity, creating an oscillation of electric and magnetic fields due to a moving charge (Nave 2005). The frequency at which this resonation occurs is consistent with that of microwaves; since electric and magnetic fields are emitted perpendicularly to each other and perpendicular to the direction of travel at this frequency, microwaves.

Castable Cement

Differential thermal analyses were made and weight losses were determined up to 1000°C for domestic and imported high-alumina hydraulic cement after hydrating. Refractory castable was prepared in the laboratory with these two cements and fire-clay brick and flint clay aggregates. Compressive, transverse, and tensile strengths of these castables were obtained after heating for 4, 8, and 12 months at 300°C and at other temperatures up to 1350°C for shorter periods of time. It is found that they are flexible to the requirements.

RF Shielding

Aluminum foil (or aluminum foil), often referred to with the misnomer tin foil, is aluminum prepared in thin metal leaves with a thickness less than 0.2 mm (7.9 mils); Aluminum foil, is a cheap and effective material to use for microwave shielding. It is available in a variety of forms, such as rolls, self-adhesive tape and attached to insulating foam boards. It is also available laminated with plastic or brown paper, such as sold for use as vapor barriers and heat reflectors. Aluminum plates are usually not used, unless there is a need to shield lower frequencies, such as from radio stations or electrical equipment.

Justification

Aluminum shielding is an important process. Since the Aluminum is a conductor of electricity, it forms a barrier often called a Faraday Cage, entirely stopping the radio waves. Other materials such as steel and copper can also be used for this process. One major disadvantage of steel is that it is efficient with frequencies below 500 MHz similarly, copper is highly efficient and also less economical.

Copper Pipes

Copper pipes are most often used for supply of hot and cold tap water, and as refrigerant line in HVAC systems. There are two basic types of copper tubing, soft copper and rigid copper. Copper tubing is joined using flare connection, compression connection, or solder.[8] Copper offers a high level of corrosion resistance but is becoming very costly. Copper has many desirable properties for thermally efficient and durable heat exchangers. First and foremost, copper is an excellent conductor of heat. This means that copper's high thermal conductivity allows heat to pass through it quickly.

Other desirable properties of copper in heat exchangers include its corrosion resistance, biofouling resistance, maximum allowable stress, and internal pressure, creep rupture strength, fatigue strength, hardness, thermal expansion, specific heat, antimicrobial properties, tensile strength, yield strength, high melting point, alloy ability, ease of fabrication, and ease of joining. The combination of these properties enables copper to be specified for heat exchangers in industrial facilities, HVAC systems, vehicular coolers and radiators, and as heat sinks to cool computers, disk drives, televisions, computer monitors, and other electronic equipment. Copper is also incorporated into the bottoms of high-quality cookware because, the metal conducts heat quickly and distributes it evenly.[9]

DESIGN AND FABRICATION

Cement Chamber

Cement chamber helps in providing a closed environment for the heating process. It consists of an inlet and an outlet pipe through which the water flows. To avoid the radiation emission to the surrounding, an aluminum foil is placed around the chamber. The simple water level indicator is made and placed inside the chamber.

Figure 1: Cement Chamber

Water Level Indicator

- The main use of this is used to indicate the water level in the chamber.
- Resistor- 220ohms (6)
- Transistors- BC 547 (4)
- LED IN 4007 (3)

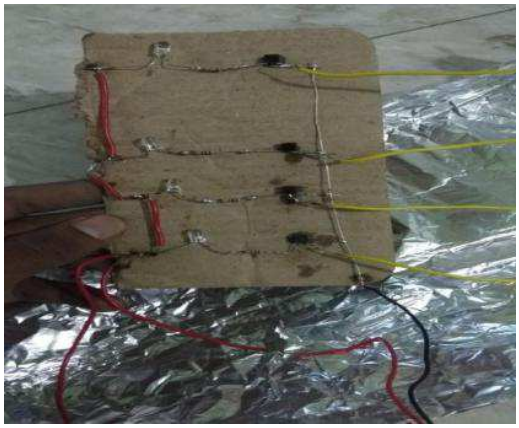

Figure 2: Water Level Indicator

Magnetron Setup

Electrical Characteristics

- Peak anode voltage (V) – 4.2kV
- Avg. anode current -300 mAdc
- Avg. output power – 945 W
- Frequency – 2458 MHz

Figure 3: Magnetron Setup

Thermocouple

A Thermocouple is a sensor used to quantify temperature. Thermocouples comprise of two wire legs produced using diverse metals. The wires legs are welded together toward one side, making an intersection. This intersection is the place the temperature is estimated.

Figure 4: Thermocouple

Heat Exchanger

The steam, which is produced, is passed through the series of copper pipes and it is condensed into water again.

Dimensions

Length : 65 cms

Breadth : 15 cms

Height : 50 cms

Heat exchanger pipe: 1/4 inch

Inlet & Drain pipe: 1/2 inch

Figure 5: Heat Exchanger

WORKING

The saline water, which is stored in a tank is fed into the heating chamber through the inlet pipe containing a valve. The water flows through the pipe and reaches the cement chamber. The flow of saline water into the chamber will be controlled using the valve. The water is filled until a sufficient level is reached. The velocity of an electromagnetic wave in free space, such as vacuum and air, is constantly 300,000 km per second regardless of frequency. Once the saline water is filled in the chamber, the microwave oven is switched on. The main source of heat production is the magnetron. The microwaves produced by the magnetron are made to pass through the chamber and tends to heat the saline water. The heat produced in the water is due to the vibration of molecules at the rate of 2.5 million per second. The water inside the tank gets super-heated as a result of magnetic waves. Once the water is super-heated, it is led out of the chamber using the outlet pipe. The outlet pipe acts as a medium, which carries the water from one place to another. The super-heated water is collected in a separate tank, where it reacts with the atmosphere and gets converted into steam. The steam so produced, is passed on to the condenser. The end product obtained from the process would be pure water.

Figure 6: Experimental Setup

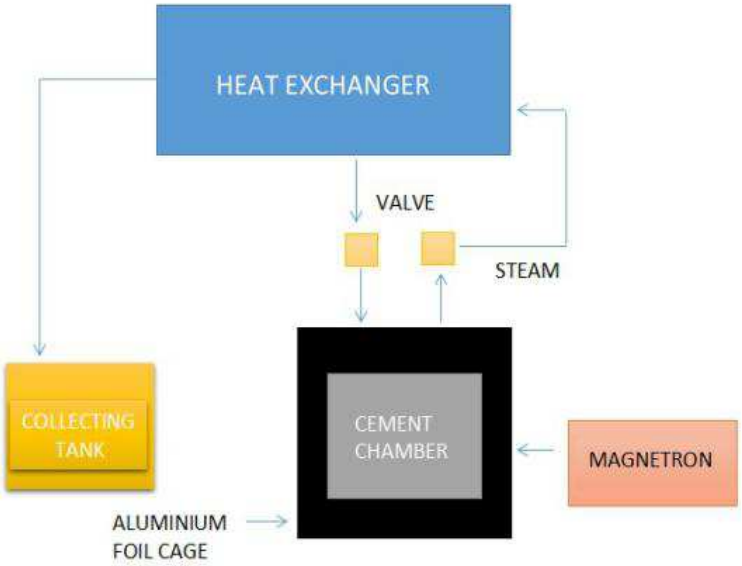

Figure 7: Process Diagram

Experimental Reading

Table 1: Temperature (0C) vs. Time (min)

S. No	Temperature (^{0}C)	Time (min)
1	25	0
2	35	7.7
3	45	15.54
4	55	23.31
5	65	31
6	75	36.8
7	85	46.62
8	95	54.39
9	100	58.27

Table 2: Time (mins) vs. Water Produced (Litres)

S. No	Time (min)	Water Condensed (litres)
1	5	0
2	10	0.150
3	15	0.275
4	20	0.700
5	25	1.25
6	30	1.90
7	35	2.50
8	40	3.21
9	45	3.96
10	50	4.8
11	55	5.6
12	60	6.4
13	65	7.1
14	70	7.6
15	75	8.2

CONCLUSIONS

According to the UN survey, approximately 25% of peoples will suffer by water scarcity in 2025, yet available 1% of fresh water is completely getting depleted. Desalination is the only source to solve the water scarcity, numerous methods are available to separate the salt content and those things are getting optimized up to the level. On next to the membrane methods, our method suits to the domestic purpose and also for the giant industrial purpose. Quick output in a short time is our advantage in this project, deposition if salt is controllable. When compared to others, maintenance is low and energy consumption and magnetron lifetime is our major dependence in this project. On our future works will fulfill those dependencies. For those safety precautions, the whole system is covered by aluminum foil and tried to build the adiabatic system to reduce the disorders and loss in the operation.

Improvements to be Made in the Present Apparatus

- More proper radiation chamber to be made.
- To make the magnetic field more uniform through the metal cavity, a mode stirrer should be annexed to the wall in front of the waveguide of the magnetron.
- Proper insulation must be made to run with more efficiency.
- Try to reduce pressure, which in turn decrease the boiling point of saline water which reduces the working time of magnetron.

Future Works

The new setup is planned for microwave production with proper shielding.

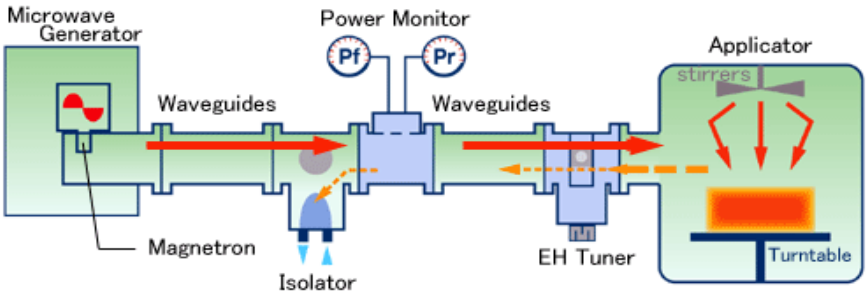

Figure 8: Microwave Power Application Setup

Generator (Oscillator) : A device that wavers microwave. The generator is associated with a wave guide has opened nozzle. The microwave, which is created by magnetron engenders in a waveguide to be discharged from the nozzle.

Isolator: A device that sends traveling wave directly to the Applicator and absorbs reflected wave by built-in dummy load to avoid returning back to the Generator. Reflected wave occurs by rotation of the Turntable and the Stirrer. Isolator can reduce the influence of reflected wave fluctuation. Without this fluctuation, magnetron can continue stable operation. In other words, Isolator functions to protect magnetron.[10]

Power Monitor: A device that monitors traveling and reflected waves of microwave power propagating through the rectangular waveguide. Must be careful when reflected wave becomes large, there is an increase in error.[10]

EH-Tuner: There are two sorts of tuners, which are three stubs and EH. EH-Tuner is suggested for simple modification. By modifying E-or H-tuner, changes the stage and extent of microwave reflection at the tuner area. It is likewise movable to set the presentation estimation of reflected capacity to zero by altering E-or H-tuner. This implies, by modifying E-or H-tuner, produces an equivalent size turn around stage wave to counter the reflected wave. What's more, subsequently, the reflected wave has been denied. When the reflected power wave esteem is zero on the showcase of Power Monitor, control utilization of after tuner to an inside instrument is expanded. This condition is classified "The matching".

Applicator: A heating tank that warms the article put inside by illumination of a microwave. Contingent upon the application, there is variety of shapes, for example, bunch-type, transport type, waveguide type, and so forth.

Waveguide: Microwave (electromagnetic wave) engenders in the communication of electric and attractive fields. Microwave is transmittable when metal pipe with a cross area is utilized. All in all, for the microwave warming hardware, the 2GHz standard rectangular waveguide of the rectangular cross area is utilized.

REFERENCES

1. *D H Gadani1, V A Rana, S P Bhatnagar, A N Prajapati & A D Vyas "Effect of salinity on the dielectric properties of water" Indian Journal of Pure and Applied Physics, Vol 50, June 2012,pp. 405-410.*
2. *Jamil Anwar, Umer Shafique, Waheed-uz-Zamana, Rabia Rehman, Muhammad Salman, Amara Dar, Jesus M. Anzano, Uzma Ashraf, Saira Ashraf " Microwave chemistry: Effect of ions on dielectric heating in microwave ", Arabian Journal of Chemistry, Volume 8, Issue 1, January 2015, Pages 100-104*
3. *Joseph Weibler "Properties of metals used for RF Shielding", EMC Test & Design, December 1993.*
4. *Natt Makul, Phadungsak Rattanadecho, Dinesh K. Agrawal "Applications of microwave energy in cement and concrete",RenewableandSustainableEnergyReviews37(2014)715–733*
5. *Niall J. English and J. M. D. MacElroy "Molecular dynamics simulations of microwave heating of water ", Journal Of Chemical Physics, Volume 118, Number 4, 22 January 2003*
6. *Al-Waily 'Theoretical, M. (2013). „Theoretical and Numerical Analysis Vibration Study of Isotropic Hyper Composite Plate Structural. International Journal of Mechanical and Production Engineering Research and Development, 3(5), 145-164.*
7. *Y. V. Bykov, K. I. Rybakov, and V. E. Semenov, "High-temperature microwave processing of materials," J. Phys. D. Appl. Phys., vol. 34.*
8. *https://en.wikipedia.org/wiki/Copper_tubing*
9. *https://en.wikipedia.org/wiki/Copper_in_heat_exchangers*
10. *https://www.microdenshi.co.jp/en/microwave/*